POPULATION DYNAMICS OF A FEW DOMINANT PLANT SPECIES AROUND INDUSTRIAL COMPLEXES, IN WEST BENGAL, INDIA[1]

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The paper deals with the population dynamics of four plant species, namely *Croton bonplandianum* Baill., *Clerodendrum viscosum* Vent., *Chromolaena odorata* (L.) King & Robinson and *Lantana camara* L. var. *aculeata* (L.) Moldenke in the vicinity of two industrial complexes at Kuntighat and Rishra in West Bengal, India. Of the four plant species, the former two were studied at Kuntighat and the latter two at Rishra. *Croton bonplandianum* and *Clerodendrum viscosum* showed higher flux rate than the others. Though all the species except, *Lantana camara,* showed high mortality rate, they produced large numbers of plants for survival. The aggressive nature of these species was noteworthy, in spite of the pronounced effect of pollutants.

INTRODUCTION

The study of vegetation in the vicinity of industrial complexes has provided excellent data indicating the response of plant population to environmental pollution (Porter, 1926; Little and Martin, 1972; Jordan, 1975). It has also revealed the capabilities of plant a species to fit into a changing environment, at the same time improving its chances of survival. Gemmell (1975) gave information concerning the plant population around an iron-smelting plant. Only grasses were able to survive in that area. Rosenberg *et al.* (1979) have studied the plant species composition at varying distances along the pollution gradient. They concluded that the wastes from industrial complexes were important in explaining the variations in plant population. Various changes may occur in soil due to continuous addition of wastes like carbon and sulphur particles, ash, heavy metals and soluble salts. The changed parameters are metal toxicity, acidity, alkalinity and non-availability of nutrients (Gemmell, 1973; Ragaini *et al.,* 1977). These can hamper the normal growth and distribution of plants. Again, soil nutrient status, rainfall, temperature and exposure to polluted environment certainly have an impact on species distribution (Hodgson and Townsend, 1973). The distribution pattern of a plant species is dependent on the interspecific and/or intraspecific interactions (Shimwell, 1971). Plant-animal interaction also controls the population size. Continuous influx of species from nearby vegetation causes the variation in plant populations. Only species having competitive reproductive abilities can survive and reproduce well in polluted habitats, others are annihilated.

In India, only a few researchers have studied the qualitative ecological aspects of flora around industrial complexes (Sreerangaswamy *et al.* 1973; Pathmanabhan *et al.* 1979). Sketchy work has been done on plant population dynamics in and around industrial centres. Sahu and Santra (1986, 1988, 1989) however, reported the ecological, morpho-anatomical and biochemical aspects of various plant species at these sites.

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The present objectives include (1) investigation of plant population flux rate, annual mortality rate, tolerance capacity and survival ability, and (2) the documentation of plant species population response to industrial pollution, which could be used for restoration, and biomonitoring of healthy environment around industrial establishments.

Material and Methods

A. Study sites

The study areas — Kuntighat and Rishra, located in southern West Bengal, India, have an average 6 m elevation. Both are already marked as polluted habitats (Sahu and Santra, 1989). The nature of waste discharges is different in these two stressed habitats (Table 1).

Table 1
STUDY SITES WITH WASTES AND SOURCE

Industrial Centre	Waste source	Wastes
Kuntighat (long 88° 35' E lat 20° 19' N)	Rayon complex, H_2SO_4 plant, CS_2-plant, Paper mills, Textile mills, etc.	SO_2, H_2S, CS_2, heavy metal, H_2SO_4 vapour and carbon dust.
Rishra (long 88° 30' E lat 20° 19' N)	Alkali chemical, Pharmaceuticals, Crop protecting chemical factory, Metallurgical works, etc.	H_2S, NaOH dust, NH_3, Cl_2, organo-phosphate chemicals, Hg and fluorides.

There are little fluctuations in temperature, rainfall, relative humidity and sunshine. Soil types are sandy-loam at Kuntighat and loamy-sand at Rishra, but the pH value of the soil differed (Kuntighat: pH 4.3-4.6; Rishra: pH 6.5-7.7) as reported earlier by Sahu (1990).

B. Methods

Quantitative sampling of species was based on their dominance pattern at the study sites. Only four species were taken into consideration. Population dynamics were calculated according to Bharadwaj and Gopal (1978). Three permanent plots (5 m x 2 m) were taken for a period of one year. Observations were made every month and plants were tagged with plastic coated copper wire at the base of each plant.

Results

The population dynamics of four taxa, namely *Croton bonplandianum* and *Clerodendrum viscosum* of Kuntighat, *Chromolaena odorata* and *Lantana camara* of Rishra, were investigated round the year. The data on various parameters were the average value of three permanent plots (10 m^2) and are depicted in Table 2.

The most common species at Kuntighat industrial complex were *Croton bonplandianum* and *Clerodendrum viscosum.* The initial and final plant density was higher in *Croton bonplandianum* than in *Clerodendrum viscosum.* But nett change, rate of change and percentage of gain was higher in *Clerodendum viscosum.* In both the cases, the total number of individuals recruited and lost throughout the year was almost the same, although the total number of individuals recorded was higher in *Croton bonplandianum.* Annual mortality rate was found to be higher in both the cases.

At the Rishra industrial complex area, two species, namely *Chromolaena odorata* and *Lantana camara* showed very low density at the starting (9-10 individuals/10 m^2) and also at the end of the experiment (12 individuals/10 m^2). Thus the nett change, rate of change and percentage of gain were also low. But survival ability of these species was higher. The number of individuals recruited, recorded and lost was noteworthy, being always higher in *Chromolaena odorata.* Annual mortality rate was low in *Lantana camara.*

Discussion

Industrial complexes produce various types of pollutants during operations. They release wastes in the form of particles or gases. The latter

TABLE 2
POPULATION DYNAMICS OF FOUR SPECIES AT KUNTIGHAT AND RISHRA INDUSTRIAL COMPLEXES

	Parameters	Values*			
		K-Cb	K-Cv	R-Co	R-Lc
(a)	Number of individuals/10 m^2 at the beginning of the year	36	12	10	9
(b)	Number of individuals/10 m^2 at the end of the year	42	19	12	12
(c)	Nett change (b-a)	+6	+7	+2	+3
(d)	Rate of change (b/a)	1.16	1.58	1.20	1.33
(e)	Gain (%) (c/a x 100)	16.67	58.33	20.00	33.33
(f)	Number of individuals recruited throughout the year	69	63	26	8
(g)	Number of individuals still survive (out of a)	8	3	7	6
(h)	Number of individuals lost (out of a)	28	9	3	3
(i)	Total plants recorded (a+f)	105	75	36	17
(j)	Total plants lost (i-b)	63	56	24	5
(k)	Annual mortality (%) (j/i x 100)	60.00	74.67	66.67	29.41

K-Cb — *Croton bonplandianum* & K-Cv — *Clerodendrum viscosum* of Kuntighat; R-Co - *Chromolaena odorata* & R-Lc - *Lantana camara* var. *aculeata* of Rishra
* Each value is the average of three permanent plots (10m^2) 75 m apart from the complexes.

are sometimes condensed to form non-volatile products. Pollutants spread around the source are deposited on soil or plant surfaces according to the mass of particles, wind direction, nature of interception, humidity, rainfall, etc. Some amount of gaseous pollutants can be absorbed by soil (Smith *et al.,* 1973). Plant surface acts as a secondary source of pollution, as the deposited products are later transferred to the soil surface by rainfall, fog, etc. The pollutants later intermix with soil, changing its nature and eventually controlling seed germination, seedling establishment, plant distribution pattern, biodiversity, dominance pattern, etc.

The study of plant population in the vicinity of industrial complexes is of great importance. The total number of species occurring in a particular area were found to be influenced both by natural phenomena and pollution. A large number of taxa were recorded in the study areas in the monsoon, due to water holding capacity of soil, seed viability, seed germination ability, in spite of the continuous addition of toxic pollutants. This is probably due to draining out of waste from the soil surface before it has been sufficiently absorbed in soil. Later, during the dry season, the number of plants recruited were less, due to higher toxicity which caused the death of some plants. Acidity and alkalinity of the soil also play an important role in determining the plant density in an area (Little and Martin, 1972).

Annual mortality rate of the relevant species was higher at both the sites. Mortality at the seedling stage was highly affected by intraspecific competition (Shimwell, 1971). The soil pH is one of the factors determining the distribution of species. Plant species vary with regard to their optimum pH requirement. At Kuntighat soil pH is highly acidic, probably resulting in high mortality rate of plants. Soil at Rishra was nearly neutral to slightly alkaline. *Lantana camara* thrives best in this habitat, while *Chromolaena odorata* fails to do so. For this reason, probably, the former showed lower annual mortality than the latter, although other factors were also involved.

Our study revealed that low survival of a species reflects different aspects of its reproductive biology, e.g. low seed viability, low food storage in seed and other external factors, e.g., soil moisture content, pH of soil and pollutant concentration within its limit.

An analysis of the impact of industrial pollutants on population flux explained that species population responded well to the environment. All taxa showed high flux rate, high mortality rate and degree of aggressiveness. It is assessed that *Croton bonplandianum*. *Clerodendrum viscosum* and *Chromolaena odorata* showed an aggressive nature. Further, these plants possessed a high capacity of pollen production, pollen germination, fertility rate, seed production, seed viability and seed germination (Harper *et al.*, 1970; Karnosky and Stairs, 1974). *Lantana camara* is a tolerant species and showed low recruitment. This is due to low fertility rate and in part due to aborted maturation of fruit (Baron, 1984).

These species may help in monitoring environmental pollution and reclamation. They may provide useful data demonstrating the degree of response to environmental deterioration.

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